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Predictors of hepatitis A vaccination among young children in the United States

Kathy K. Byrd[a,*], **Tammy A. Santibanez**[b], and **Sandra S. Chaves**[a]

[a]Division of Viral Hepatitis, National Center for HIV, Hepatitis, STD and TB Prevention, Centers for Disease Control and Prevention, 1600 Clifton Road, NE, MS G-37, Atlanta, GA 30333, United States

[b]Immunization Services Division, National Center for Immunization and Respiratory Diseases, Centers for Disease Control and Prevention, United States

Abstract

We analysed data from the 2009 National Immunization Survey to determine potential predictors of hepatitis A vaccination coverage among children aged 19–35 months. Overall national coverage was 75% for ≥1 dose. Residence in a state with hepatitis A vaccination recommendations prior to 2006, or in a metropolitan statistical area within such state, or being a minority child were among the variables independently associated with higher vaccination coverage. While hepatitis A vaccination coverage has improved since nationwide routine childhood vaccination began in 2006, coverage remains lower than that for other recommended childhood vaccines.

Keywords

Hepatitis A vaccination; Hepatitis A virus; Predictors of vaccination

1. Introduction

Hepatitis A virus transmission occurs most frequently from person to person, especially in family settings [1]. Young children have mostly asymptomatic or unrecognized infections and play a key role in hepatitis A transmission as they serve as a source of infection for others [2,3]. The incidence of hepatitis A in the U.S. has historically varied by region with the highest rates occurring in the western and southwestern states [4]. Also, racial and ethnic disparities associated with symptomatic hepatitis A have been well documented. In the past, the highest rates of hepatitis A were among the American Indian and Alaska Native (AI/AN) population who had rates of greater than 60 cases per 100,000 people before 1996 [5]. Living conditions such as household crowding and lack of in-home water or sanitation services in many communities may have made AI/AN Peoples particularly vulnerable to hepatitis A infection. Among persons of Hispanic ethnicity, hepatitis A incidence has also

*Corresponding author. Tel.: +1 404 718 8541; fax: +1 404 718 8595. gdn8@cdc.gov (K.K. Byrd).

been higher than that of the general U.S. population [6]. Although substantially less than among AI/AN populations, incidence of hepatitis A in Hispanic children, in 1997, was more than ten times that among non-Hispanic white and black children [7]. Residence in a rural community near the U.S. – Mexico border, history of living in an endemic country, and cross-border travel to Mexico have all been associated with increased hepatitis A incidence among U.S. Hispanic children [8,9].

In 1996, after a hepatitis A vaccine was licensed in the U.S. as a two dose regimen for children aged ≥24 months, the Advisory Committee on Immunization Practices (ACIP) recommended hepatitis A vaccination for children living in communities with high rates of disease [6]. These communities were well defined ethnically and geographically and included AI/AN, Pacific Islander and some Hispanic communities [6]. In 1999, the ACIP expanded its recommendation to include vaccination of all children ≥24 months of age living in seventeen states in which hepatitis A rates were consistently above the national average; 11 states were recommended for vaccination and an additional 6 states were recommended for consideration of vaccination of children ≥24 months of age [4]. By 2005, in spite of the limited scope of recommendations for hepatitis A vaccination and the low coverage rates achieved nationally (<30%), the U.S. documented a dramatic reduction in hepatitis A disease burden among all age groups across the country [5,10–12]. Additionally, in 2005, hepatitis A vaccine was licensed for children aged 12–23 months. Considering these developments, in 2006, the ACIP revised its recommendations for childhood hepatitis A vaccination again, by targeting all children in the U.S. for two dose hepatitis A vaccination and by reducing the recommended age for vaccination from ≥24 months to 12–23 months [13].

Using data from the 2009 National Immunization Survey (NIS), this study examines variables associated with uptake of hepatitis A vaccination in the U.S. after implementation of the 2006 ACIP recommendations. The 2009 NIS includes the first cohort in which all of the infants turned 12 months of age after implementation of the new recommendations. One dose of hepatitis A vaccine leads to protective levels of antibodies in over 90% of infants and adolescents [14]; the second dose is believed to provide long lasting vaccine induced immunity. As such, this study examines variables associated with uptake of ≥1 dose of hepatitis A vaccine rather than factors associated with completing the vaccine series. Hepatitis A series completion coverage (≥2 doses), from the 2009 NIS, has been previously reported [15].

2. Methods

The NIS is an ongoing, national, random-digit-dial telephone survey of households with children aged 19–35 months at the time of interview. The household telephone survey is followed by a mail survey to all of the children's immunization providers to collect immunization histories. Vaccination coverage estimates are based upon the provider-reported vaccination information. The survey response rate (The Council of American Survey Research Organizations [CASRO] response rate) is defined as the composite response rate obtained by multiplying the rates for resolution, screener completion, and interview completion. In 2009, the NIS was conducted in each of the 50 states and in 13

select local areas. Methodological details of the NIS have previously been published [16]. Our report is based on interviews conducted between January 6, 2009 and February 10, 2010 for children born between January 2006 and July 2008.

Demographic characteristics were obtained during the telephone interview of the parent/guardian. Vaccination coverage was estimated and stratified by the following demographic characteristics: race/ethnicity; sex; whether child was the first born; family income level (below poverty; middle income: above poverty but <$75,000/year, and high income ≥ $75,000/year); number of children in the household; mother's age; mother's marital status; mother's education; metropolitan statistical area (MSA; central city, non-central city and non-metropolitan statistical area); vaccine provider type; Vaccine for Children (VFC) program eligibility; health insurance status and vaccine policy. Poverty level was determined based upon reported household income and the reported number of people in the household, using the U.S. poverty thresholds. Type of vaccine provider was defined as the type of provider that the child visited for all of their vaccinations. Provider type was categorized as follows: all public, all hospitals, all private, "other" or a mixture of provider types, or child received no previous vaccinations. The VFC program is a federal entitlement program that provides free vaccines to children younger than 19 years who are AI/AN or who are uninsured, Medicaid insured, or are underinsured and who receive vaccines at federally qualified health or rural centers. Insured children had either private insurance or insurance through Medicaid, S-Chip (State Child's Health Insurance Program), the Indian Health Service or military. Based on vaccine policy, states were divided into two categories: those with vaccination recommendation prior to 2006 (defined as a state that fell under the 1999 ACIP recommendation for vaccination or for consideration of hepatitis A vaccination) and those with no vaccination recommendation prior to 2006.

The associations between hepatitis A vaccination coverage (≥1 dose) and demographic variables were tested using Wald chi- square tests followed by pair-wise *t*-tests when the overall test of association was statistically significant. A multivariable logistic regression analysis was conducted to determine independent predictors of receipt of one or more doses of hepatitis A vaccine and to calculate adjusted vaccination coverage, i.e. predicted marginals. All demographic variables statistically significant in the bivariate analyses were included in the regression model. The possible interaction of MSA and vaccine policy was examined based on a previous study which showed an interaction between these variables [17]. The interaction was examined graphically rather than tested in the model due to recent literature suggesting that statistical testing of interactions in non-linear models is not as informative as a graphical analysis [18,19]. A two-sided significance level of 0.05 was used for all statistical tests. All data were weighted to population totals and to adjust for households having multiple telephone lines, households without land-line telephones, household unit non-response, and provider non-response. Analysis was conducted using SAS, release 9.2 (SAS Inc., Cary, NC) and SUDAAN, release 10.0.1 (Research Triangle Institute, Research Triangle Park, NC).

3. Results

The 2009 NIS included a total of 24,068 household interviews for a CASRO response rate of 64% [15]. Adequate provider-reported vaccination data were obtained for 69% of children with completed household interviews. A total of 17,053 children were included in the study.

Demographic characteristics of the sample are included in Table 1. Overall, 50.3% of the children were non-Hispanic white, 28.0% were Hispanic and 12.7% were non-Hispanic black. Fifty-one percent of children were male. Ninety-five percent had health insurance and 49.7% were VFC eligible. Twenty-one percent lived below the federal poverty level and 16.6% lived in non-metropolitan areas. Almost two-third (62%) resided in states that first began routine childhood hepatitis A vaccination in 2006.

Overall, 75.0% (95% CI: 73.9–76.1%) of children received at least one dose of hepatitis A vaccine. Findings from our bivariate analysis showed that receipt of ≥1 dose of hepatitis A vaccine was significantly associated with race/ethnicity; white, non-Hispanic children had significantly lower coverage than children from Hispanic, non-Hispanic AI/AN, non-Hispanic Asian, and non-Hispanic Native Hawaii, other Pacific Islander (NHOPI) ethnic and racial groups (all *P*-values <0.05). Other significant pair-wise comparisons are denoted in Table 2 and Fig. 1. Children below the poverty level had higher coverage (78.3%, 95%CI: 76.0–80.4%) than children living in high (72.7%, 95%CI: 70.7–74.7%) or in middle income households (73.5%, 95%CI: 71.8–75.3%). Children with health insurance had significantly higher coverage (75.6%, 95%CI 74.5–76.7%) than uninsured children (64.0, 95%CI 57.3–70.1%). Residence in a central city area and residence in a state with hepatitis A vaccination recommendations prior to 2006 were also significantly associated with hepatitis A vaccination coverage (Table 2). No other demographic variable, including VFC eligibility and vaccine provider type, was significantly associated with hepatitis A vaccination coverage.

MSA modified the effect of vaccine policy. Children living in central city and non-central city areas, in states with vaccination recommendations prior to 2006, were more likely to be vaccinated than children from states with no prior recommendation. There was no difference in vaccination coverage by vaccine policy for children living in non-MSA areas (Fig. 2).

While overall, children who resided in states with hepatitis A vaccination recommendations prior to 2006 had higher coverage than children from states without prior recommendations, vaccination coverage per individual state varied widely: coverage ranged from a low of 37.8% (95%CI: 31.1–44.5%) in Maine to a high of 90.1% (95%CI: 86.4–93.8%) in Oklahoma. Although the majority of states with ≥80% coverage were states with vaccination recommendations prior to 2006, several states that first began routine childhood hepatitis A vaccination in 2006, had higher coverage than states with prior recommendations (particularly when compared to states whose recommendation was to consider vaccination) (Fig. 3).

Based on the multivariable logistic regression model, race/ethnicity, insurance status, MSA, and vaccine policy were all significantly associated with receipt of at least one dose of hepatitis A vaccine. There was no difference in vaccination coverage by family income level.

White, non-Hispanic children were significantly less likely to be vaccinated (73.1%, 95%CI: 71.7–74.5%) than Hispanic (79.4%, 95%CI: 76.7–82.1%), non-Hispanic Asian (81.6%, 95%CI: 75.6–87.6%), non-Hispanic NHOPI (89.7%, 95%CI: 83.8–95.6%), and non-Hispanic AI/AN children (85.9%, 95%CI: 75.5–96.3%). There was no difference in vaccination coverage among white children compared to either black (72.0%, 95%CI: 68.7–75.3%) or multi-race, non-Hispanic children (72.6%, 95%CI: 67.3–77.9%). Having health insurance and residence in a central city, non-central city or in a state with vaccination recommendations prior to 2006 was significantly associated with hepatitis A vaccination coverage (Table 2).

4. Discussion

Incorporation of hepatitis A vaccine into the nationwide, routine early childhood vaccination schedule was an important strategy to improve vaccination coverage. National vaccination coverage (≥1 dose) significantly increased from 26%, among children aged 24–35 months in 2006 [20] to 75% among 19–35 month old children in 2009. The ACIP, however, recommends a two dose hepatitis A vaccine regimen; as previously reported, ≥2 dose coverage was considerably less than ≥1 dose coverage at 47%, in 2009 [15]. Low series completion is concerning because the second dose of vaccine likely promotes longer lasting vaccine-induced immunity.

While hepatitis A vaccination coverage has increased since routine childhood vaccination began in 2006, it remains substantially lower than that of other recommended childhood vaccines. For example, in 2009, coverage for MMR and polio was over 90% for each [15]. Routine childhood hepatitis A vaccination, however, is a newer recommendation and lower vaccination coverage likely reflects a lag in uptake often seen with newly recommended vaccines.

Unlike for other childhood vaccines, minority groups (with the exception of non-Hispanic black and non-Hispanic multi-race children) were more likely to be vaccinated for hepatitis A even after controlling for place of residence (e.g. MSA and prior recommendation state) and insurance status. This finding is in contrast to many studies of vaccination coverage for other diseases in which race and ethnicity were considered. In a 2009 NIS analysis of vaccination coverage for rotavirus and pneumococcus, black, non-Hispanic and multirace children had lower coverage when compared to white, non-Hispanic children; among black children, the association held for rotavirus even after adjusting for poverty status [15]. Earlier vaccination coverage studies, with a variety of childhood vaccines, have shown that black children were less likely to be vaccinated than white children [21]. Asian children, in general, have had higher vaccination coverage for various recommended vaccines, than non-Hispanic white children; increased hepatitis A vaccination coverage seen in this study follows that same trend [21]. Vaccination coverage by racial group has, however, varied in the past, depending on the individual vaccine and gaps have tended to lessen over time.

Higher hepatitis A vaccine coverage among AI/AN and Hispanic children, perhaps should not be unexpected due to the historical high incidence, targeted vaccination programs, and continued higher prevalence of risk factors in these populations; these risk factors might

have contributed to both parental and healthcare provider perception of increased risk and this, combined with access to vaccine (e.g. insurance coverage), resulted in increased vaccination coverage. Vaccination programs targeted at minority children were at least partly the result of the 1996 ACIP hepatitis A vaccination recommendation which targeted communities with high rates of disease, many of which were AI/AN, Pacific Islander and Hispanic communities. In addition, the Indian Health Service (IHS) has a longstanding hepatitis A vaccination program; in 1995–1996, the IHS instituted childhood hepatitis A immunization programs in certain Northern Plains reservations and later expanded to include all IHS healthcare facilities [22].

Children from non-MSA communities had decreased vaccination coverage when compared to children from MSA communities. Decreased hepatitis A vaccination coverage in non-MSA children may reflect decreased access to vaccination providers. Studies on accessibility to vaccination providers have shown that increased concentration of pediatricians and higher spatial accessibility to pediatric vaccination providers are associated with increased vaccination coverage [23,24]. Decreased numbers of pediatricians in non-MSA areas may make access to vaccination providers diffi-cult for non-MSA children. However, in 2008, vaccination coverage for MMR, DTaP and polio was not associated with MSA [25]. Hepatitis A vaccination coverage in non-MSA areas should be further examined to determine factors associated with decreased vaccination in these communities and to determine if decreased coverage continues.

Overall, the seventeen states with vaccination recommendations prior to 2006 continue to have higher vaccination coverage than those states that began routine childhood hepatitis A vaccination in 2006. Higher vaccination in these states likely reflects a history of high incidence of disease and mature vaccination programs. For example, in 2008, most states that required hepatitis A vaccination for entrance into daycare (8 of 12 states) or into kindergarten (4 of 7 states) were from the prior recommendation states [26]. Required vaccination for daycare and kindergarten likely increased overall vaccination coverage in these areas. In addition, even in the absence of prior vaccination recommendations, 3 of 4 states (North Dakota, Georgia and Washington D.C.) with a daycare vaccination requirement had high (≥88%) vaccination coverage indicating that state mandates might play a role in increased hepatitis A coverage.

States that began vaccinating in 2006 have increased vaccination coverage dramatically from 7% in 2006 (CDC, unpublished data) to 71% in 2009. With the rapid rise in vaccination in the 33 states which began routine vaccination in 2006, there will likely be little difference in overall vaccination coverage between those states that fell under the prior and the new recommendations in the next few years. In addition, we found large variability in coverage between individual states, even among states with prior vaccination recommendations. Efforts should continue to provide consistent and uniform coverage to all children.

Our results should be viewed in light of the study limitations. First, NIS is a landline telephone survey which may be subject to nonresponse and noncoverage bias. Studies have shown, however, that statistical adjustment adequately compensates for noncoverage of households without telephones [27]. Second, we may have underestimated vaccination

coverage due to the use of provider-reported vaccination histories only; completeness of provider records is unknown. Lastly, there were small sample sizes of AI/AN, NHOPI and Asian children which led to increased variability within the vaccination coverage estimate.

5. Conclusion

In 2009, approximately 75% of children 19–35 months of age were vaccinated with at least 1 dose of hepatitis A vaccine. Vaccination coverage was independently associated with race/ethnicity, residing in a state with vaccination recommendations prior to 2006, and residing in metropolitan statistical areas. While there has been considerable improvement in hepatitis A vaccination coverage since nationwide routine childhood vaccination began in 2006, coverage remains lower than that for other recommended childhood vaccines. Although hepatitis A incidence is currently low, acute cases continue to occur in the U.S. Because hepatitis A-associated morbidity is more severe in adults than in children [6], efforts should be made to avoid accumulating a pool of susceptible adults who escaped both naturally acquired hepatitis A infection and childhood hepatitis A vaccination. Efforts, therefore, should continue to increase vaccination coverage among all children.

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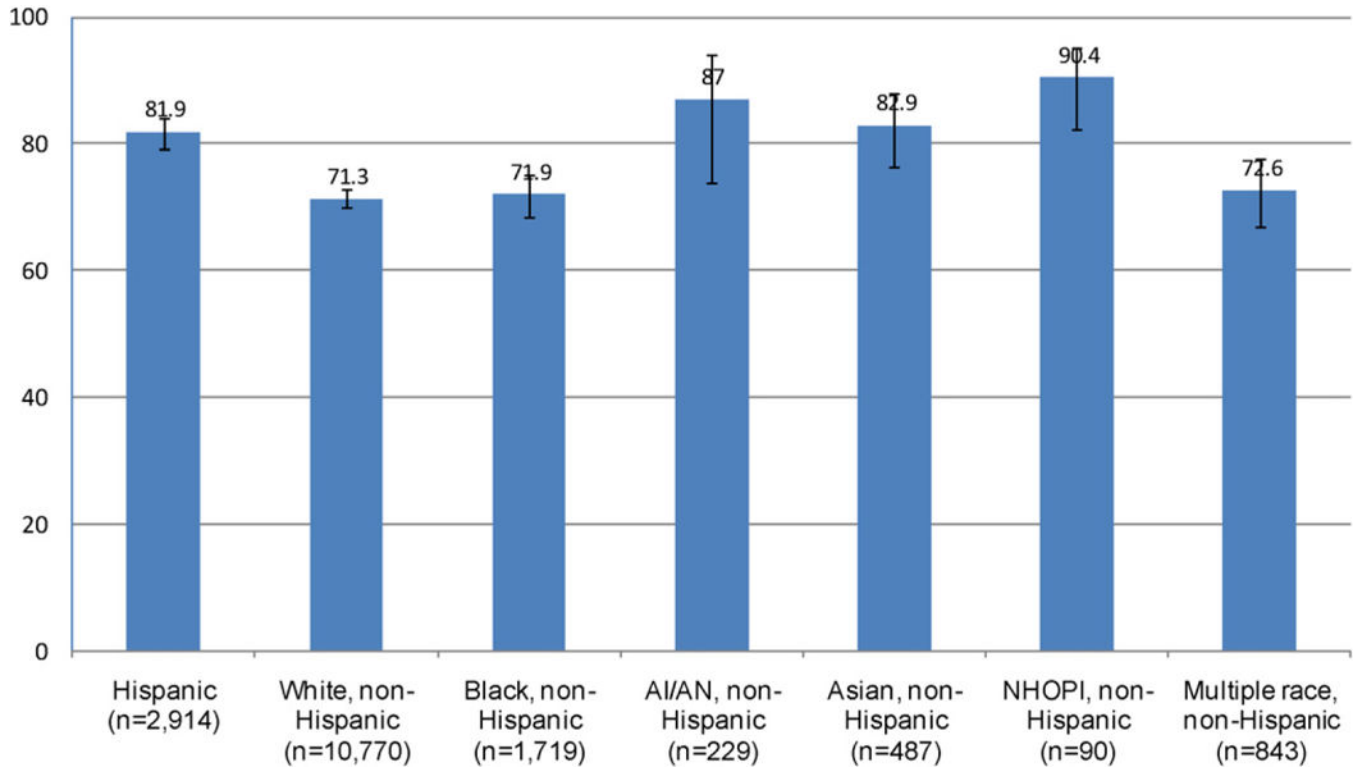

Fig. 1.

Vaccination coverage with ≥1 dose of hepatitis A vaccine among children aged 19–35 months by race/ethnicity, 2009 National Immunization Survey. Based on post hoc pair-wise comparisons, Hispanic children had significantly higher coverage than white, black, and multiple race non-Hispanic children and significantly lower coverage than non-Hispanic Native Hawaiian, other Pacific Islander (NHOPI) children; additionally white non-Hispanic children had significantly lower coverage than American Indian/Alaska Native (AI/AN) non-Hispanic, Asian non-Hispanic, and NHOPI non-Hispanic children; Black non-Hispanic children had lower coverage than Asian non-Hispanic children; AI/AN had higher coverage than multiple race children (all *P*-values <0.05); no other pair-wise comparisons were statistically significant.

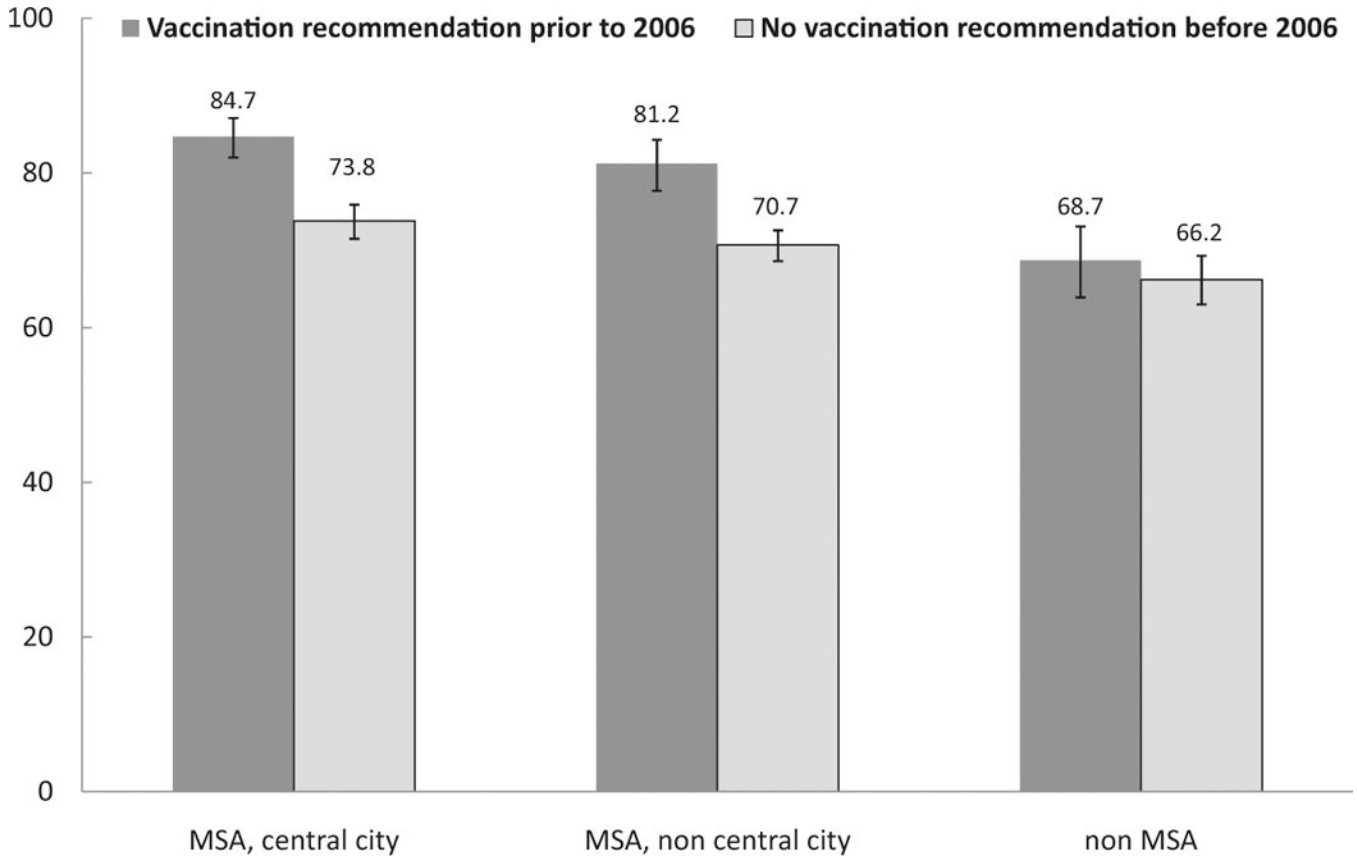

Fig. 2.

Hepatitis A vaccination coverage (≥1 dose) by vaccine policy (states with vaccination recommendations prior to 2006 and states with no vaccination recommendation prior to 2006) and metropolitan statistical area (MSA), National Immunization Survey, 2009.

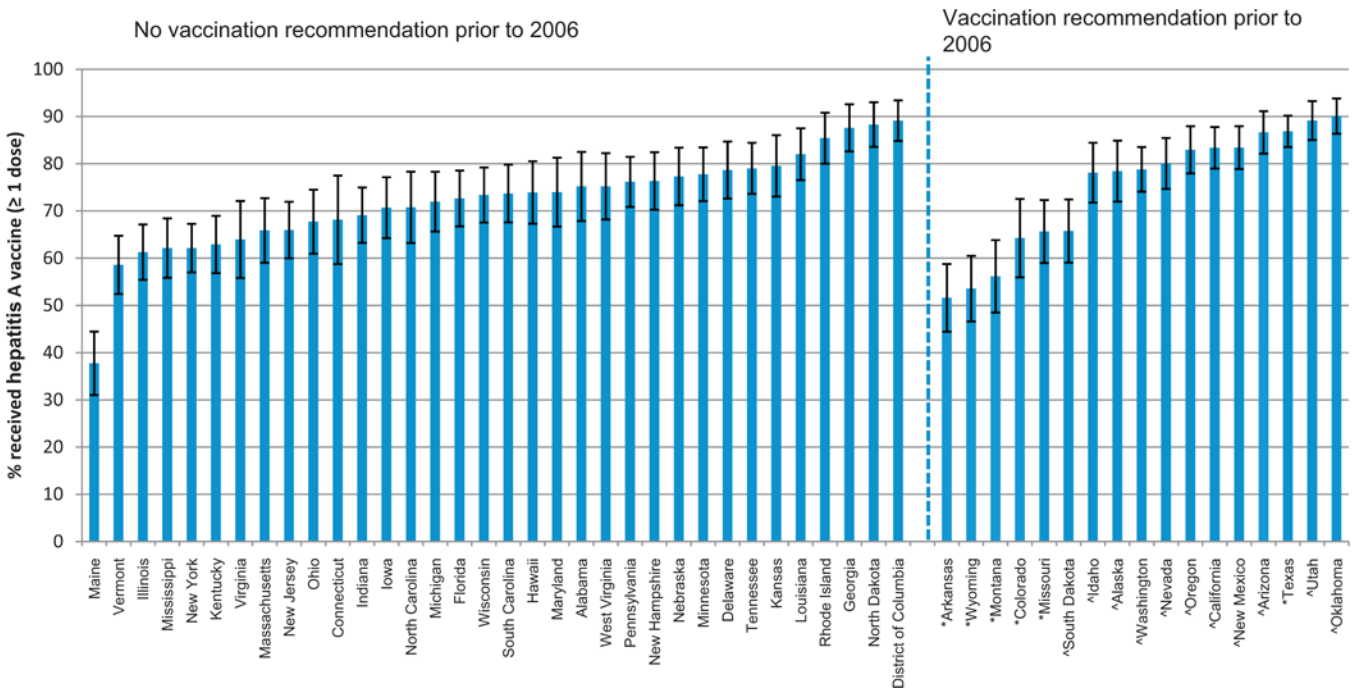

Fig. 3.

Hepatitis A vaccination coverage (≥1 dose) by state and vaccine policy, National Immunization Survey, 2009. ^ Indicates a state with a vaccination recommendation for routine vaccination prior to 2006. *Indicates a state with a vaccination recommendation to consider vaccination prior to 2006.

Table 1

Demographic characteristics of the sample, National Immunization Survey, 2009.

		Overall		States with an ACIP recommendation prior to 2006		States without an ACIP recommendation prior to 2006	
Characteristic		**n**	**% ± 95%CI**	**n**	**% ± 95%CI**	**n**	**% ± 95%CI**
Overall		17,053	100%	6135	100%	10,918	100%
Race/ethnicity	Hispanic	2914	28.0 ± 1.4	1706	43.7 ± 2.7	1208	18.3 ± 1.3
	Non-Hispanic White	10,771	50.3 ± 1.3	3492	39.8 ± 2.4	7279	56.8 ± 1.5
	Non-Hispanic Black	1719	12.7 ± 0.9	286	6.0 ± 1.2	1433	16.8 ± 1.2
	Non-Hispanic AIAN	229	0.9 ± 0.2	175	1.6 ± 0.5	54	0.5 ± 0.2
	Non-Hispanic Asian	487	3.0 ± 0.5	154	3.9 ± 1.2	333	2.5 ± 0.4
	Non-Hispanic NHOPI	90	0.4 ± 0.2	25	0.6 ± 0.5	65	0.3 ± 0.1
	Non-Hispanic Multiple race	843	4.7 ± 0.5	297	4.4 ± 1.0	546	4.9 ± 0.6
Sex	Male	8776	51.2 ± 1.4	3147	51.2 ± 2.7	5629	51.2 ± 1.5
	Female	8277	48.8 ± 1.4	2988	48.8 ± 2.7	5289	48.8 ± 1.5
First Born	No	9199	53.8 ± 1.4	3461	56.3 ± 2.7	5738	52.3 ± 1.5
	Yes	7854	46.2 ± 1.4	2674	43.7 ± 2.7	5180	47.7 ± 1.5
Poverty level	Above, >$75K	6290	27.0 ± 1.1	1933	24.8 ± 2.2	4357	28.3 ± 1.2
	Above, ≤$75K	6694	36.8 ± 1.3	2561	33.5 ± 2.4	4133	38.9 ± 1.5
	Below	3508	31.2 ± 1.4	1461	36.5 ± 2.8	2047	27.8 ± 1.5
	Unknown	561	5.0 ± 0.7	180	5.2 ± 1.3	381	4.9 ± 0.7
Number of children in HH	1	3984	22.3 ± 1.1	1266	18.6 ± 1.9	2718	24.6 ± 1.3
	2–3	10,664	61.2 ± 1.4	3797	62.0 ± 2.6	6867	60.7 ± 1.5
	≥4	2405	16.5 ± 1.1	1072	19.3 ± 2.3	1333	14.7 ± 1.2
Mother’s age	≤19 years	317	3.2 ± 0.6	118	3.2 ± 1.2	199	3.2 ± 0.6
	20–29 years	5507	37.7 ± 1.4	2122	37.6 ± 2.7	3385	37.7 ± 1.5
	≥30 years	11,229	59.2 ± 1.4	3895	59.2 ± 2.7	7334	59.1 ± 1.5
Mother’s marital status	Ever married	13,969	75.3 ± 1.3	5103	76.7 ± 2.4	8866	74.5 ± 1.4
	Never married	3084	24.7 ± 1.3	1032	23.3 ± 2.4	2052	25.5 ± 1.4
Mother’s education	≤12 years	4864	50.7 ± 1.4	1976	55.1 ± 2.6	2888	47.9 ± 1.5
	>12years, not grad	4457	18.9 ± 0.9	1687	18.0 ± 1.8	2770	19.5 ± 1.0
	College graduate	7732	30.4 ± 1.1	2472	26.9 ± 2.1	5260	32.6 ± 1.2

Characteristic		Overall		States with an ACIP recommendation prior to 2006		States without an ACIP recommendation prior to 2006	
		n	% ± 95%CI	n	% ± 95%CI	n	% ± 95%CI
MSA status	MSA, central city	7181	42.3 ± 1.4	2965	50.8 ± 2.7	4216	37.1 ± 1.4
	MSA, non-central city	6071	41.1 ± 1.3	1721	37.0 ± 2.6	4350	43.7 ± 1.4
	Non-MSA	3801	16.6 ± 0.8	1449	12.2 ± 1.2	2352	19.3 ± 1.1
Provider type	All Public	1757	11.5 ± 0.9	707	12.1 ± 1.8	1050	11.2 ± 1.0
	All hospitals	1925	10.4 ± 0.9	532	8.4 ± 1.7	1393	11.6 ± 1.0
	All private	10,421	61.1 ± 1.4	3558	59.0 ± 2.7	6863	62.4 ± 1.5
	Other/mixed	2778	16.4 ± 1.0	1260	19.8 ± 2.2	1518	14.3 ± 1.0
	Not applicable/unvaccinated	172	0.6 ± 0.1	78	0.6 ± 0.2	94	0.6 ± 0.2
VFC eligible	Yes	6292	49.7 ± 1.4	2493	53.2 ± 2.7	3799	47.5 ± 1.5
	No	10,675	50.3 ± 1.4	3610	46.8 ± 2.7	7065	52.5 ± 1.5
Insurance	Uninsured	660	5.4 ± 0.7	350	7.3 ± 1.4	310	4.2 ± 0.7
	Has health insurance	16,391	94.6 ± 0.7	5785	92.7 ± 1.4	10,606	95.8 ± 0.7

Table 2

Unadjusted and adjusted estimates of hepatitis A vaccination coverage (≥1 dose), among children aged 19–35 months, National Immunization Survey, 2009, United States.

		Unadjusted % ± 95%CI half-width[a]	Adjusted % ± 95%CI half-width[†]
Overall		75.0 ± 1.1	
Race/ethnicity	Hispanic	81.9 ± 2.4	79.4 ± 2.7
	Non-Hispanic White	71.3 ± 1.4	73.1 ± 1.5
	Non-Hispanic Black	71.9 ± 3.3	72.0 ± 3.3
	Non-Hispanic AI/AN	87.0 ± 9.8	85.9 ± 10.4
	Non-Hispanic Asian	82.9 ± 5.8	81.6 ± 6.0
	Non-Hispanic NHOPI	90.4 ± 6.2	89.7 ± 5.9
	Non-Hispanic Multiple race	72.6 ± 5.5	72.6 ± 5.3
Poverty level	Above, >$75K	72.7 ± 2.0	72.8 ± 2.2
	Above, ≤$75K	73.5 ± 1.7	74.8 ± 1.7
	Below	78.3 ± 2.2	76.9 ± 2.3
	Unknown	77.1 ± 5.5	77.0 ± 5.5
Insurance	Uninsured	64.0 ± 6.4	61.3 ± 6.5
	Has health insurance	75.6 ± 1.1	75.7 ± 1.1
Metropolitan statistical area (MSA) status	MSA, central city	78.8 ± 1.7	77.7 ± 1.7
	MSA, non-central city	74.3 ± 1.8	75.0 ± 1.8
	Non-MSA	66.9 ± 2.6	68.6 ± 2.6
Vaccine policy	States with vaccination recommendation prior to 2006	81.4 ± 1.9	80.1 ± 1.9
	States with no vaccination recommended prior to 2006	71.0 ± 1.3	72.0 ± 1.4

[a]Based on bivariate analysis, the following were statistically significant: Hispanic versus white, black, Native Hawaiian, other Pacific Islander (NHOPI), and multiple race; white versus American Indian and Alaska Native (AI/AN), Asian, and NHOPI; black versus AI/AN and NHOPI; AI/AN versus multiple race; below poverty versus above >$75K, above ≤$75K; uninsured versus insured; non-MSA versus MSA central city and MSA non-central city; MSA central city versus MSA non-central city; states with vaccination recommendation prior to 2006 versus states without a recommendation prior to 2006; all *P*-values <0.05.

[†]Based on the multivariable logistic regression, poverty level did not remain statistically significant in the model; all other variables were statistically significant.